What does neuropsychology have to offer to the world of stroke rehabilitation?

Fiona Allanson

Clinical Neuropsychologist Registrar

Fiona.Allanson@research.uwa.edu.au

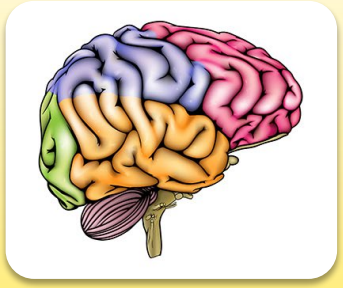
3rd Western Australian Stroke Symposium

SHOUT
SHARE
IT

Who am I?

- Clinical Neuropsychologist Registrar
- PhD Candidate
- Inaugural winner of the Brightwater Lyn Beazley Scholarship

ABI:RECOVER Project



Designed to look at recovery following acquired brain injury

Aims to:

- Identify skills important for recovery
- Develop interventions targeting promising skills

Multi-student project

What is a clinical neuropsychologist?

*"Clinical neuropsychologists **assess and treat** people with **brain disorders** that affect memory, learning, attention, language, reading, problem solving, and decision making"* *(APS, 2019)*

Neuropsychology in stroke

THE UNIVERSITY OF WESTERN AUSTRALIA

Assessment:

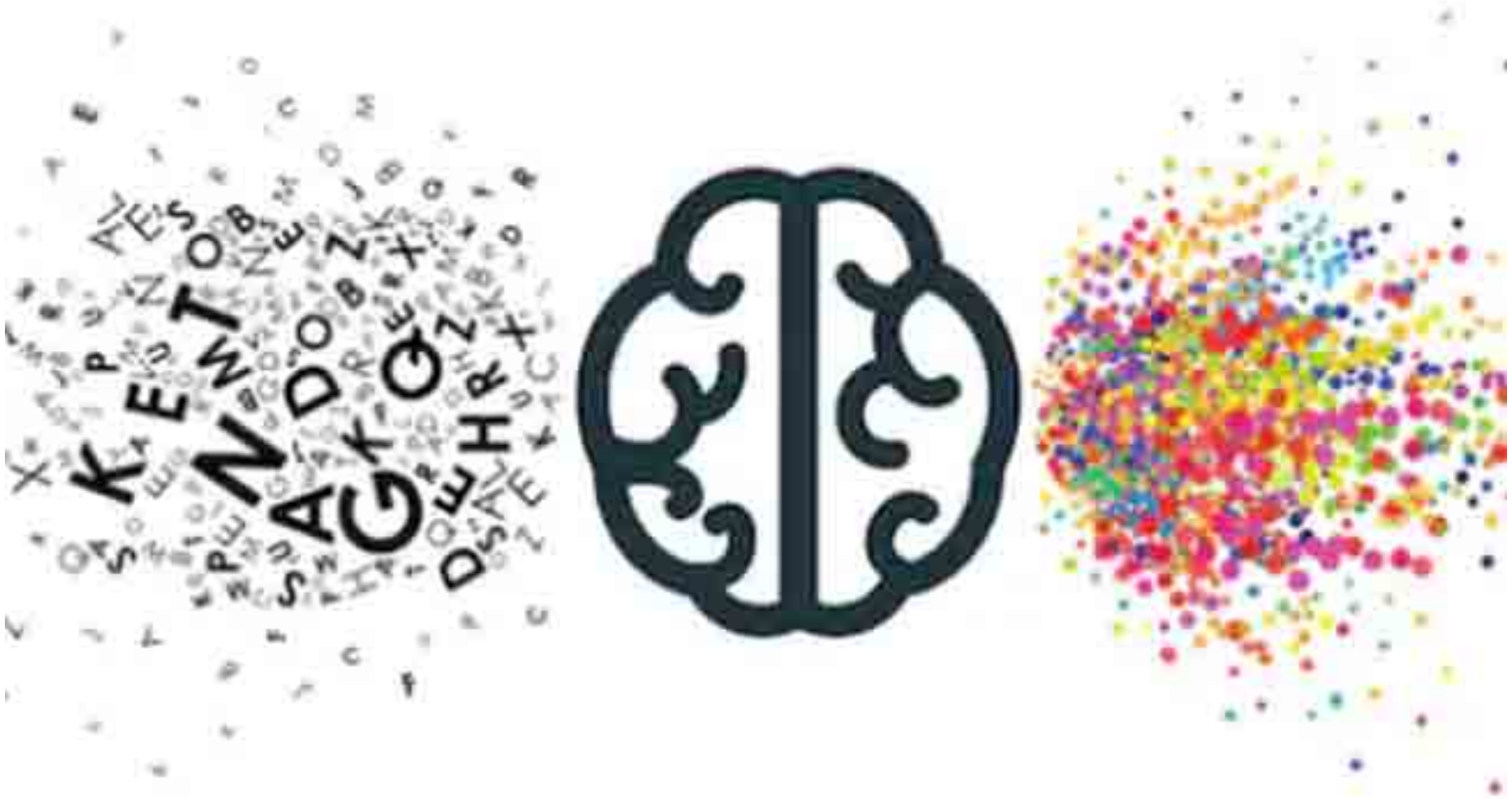
- Assess the domain-specific impact of stroke
  - Take into account pre-morbid functioning and age
  - Modify test battery for particular presentations
  - Characterise what might be impacted, including neurobehavioural changes such as apathy
- Helps to predict functional outcome

Feedback and Intervention:

- Psycho-education
- Build self-awareness
- Rehabilitation approaches

ASSESSMENT

What is a neuropsychological assessment?



Neuropsychological Assessment

THE UNIVERSITY OF WESTERN AUSTRALIA

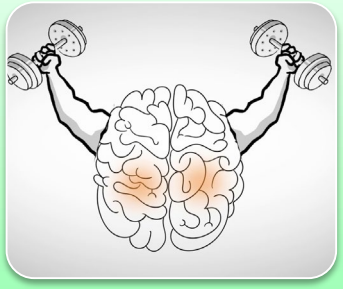
Intelligence	Memory and Learning	Executive Functioning
Language	Visuo-Spatial Skills	Processing Speed
Emotion/Mood	Adaptive Functioning	Social Cognition

Stroke Foundation Recommendations

"Stroke survivors identified during screening as having cognitive deficits should be referred for comprehensive clinical neuropsychological investigations"

Cognitive impairment

Between 20 and 97% of people experience cognitive impairment following stroke (Chan et al., 2014; Sun et al., 2014)



Impairment is still seen in people with "good" recovery (Jokinen et al., 2015; Planton et al., 2012)

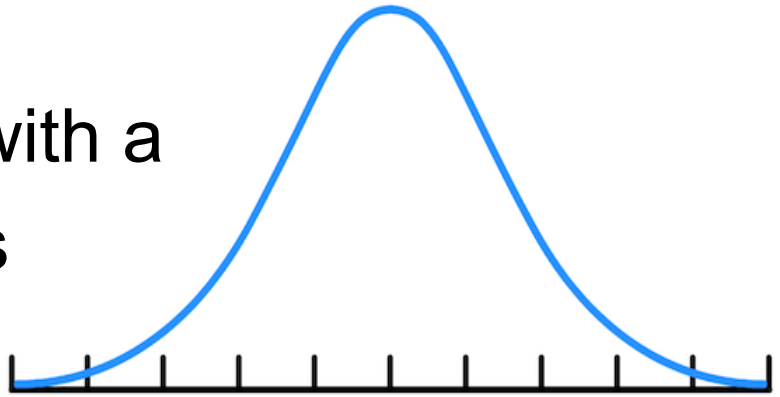
Most frequently, impairments are seen in memory, processing speed, visuo-spatial construction, executive functioning, and language (Jokinen et al. 2015; Planton et al., 2012)

Neuropsychology and stroke

Neuropsychologists also use *normative data* to characterise what is expected based on someone's age or gender.

Neuropsychological tests can estimate a *pre-morbid baseline* using tests of skills thought to be relatively resistant to neurological damage.

Neuropsychologists can work with a range of different presentations



Neuropsychological Assessment

THE UNIVERSITY OF WESTERN AUSTRALIA

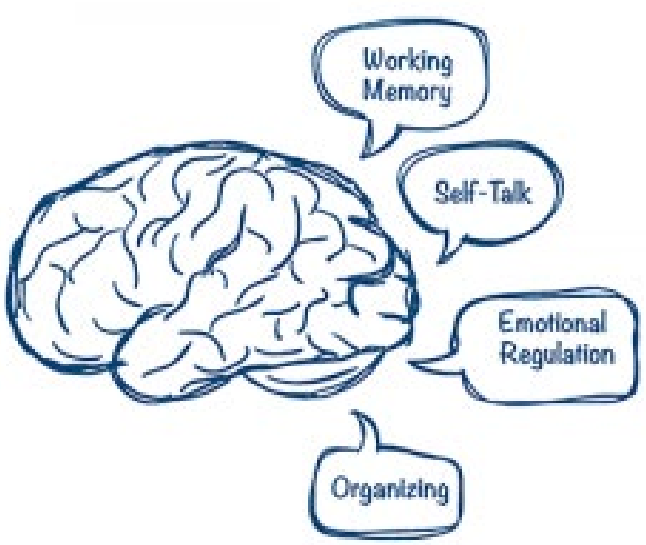
Intelligence	Memory and Learning	Executive Functioning
Language	Visuo-Spatial Skills	Processing Speed
Emotion/Mood	Adaptive Functioning	Social Cognition

Neuropsychological Assessment

THE UNIVERSITY OF WESTERN AUSTRALIA

Intelligence	Memory and Learning	Executive Functioning
Language	Visuo-Spatial Skills	Processing Speed
Emotion/Mood	Adaptive Functioning	Social Cognition

Executive Functioning



Broadly, there are three "prefrontal" syndromes:

1) Dorsolateral
2) Ventromedial/Orbitofrontal
3) Medial frontal

(Bechara et al., 2000; Bechara et al., 2005; Petersen et al., 2012; Pohjasvaara et al., 2002; Scott &Schoenberg, 2011; Tekin &Cummings, 2002)

Executive Functioning

THE UNIVERSITY OF WESTERN AUSTRALIA

Cold

- Logical or rational higher order processes used in novel tasks
- Includes set shifting, working memory updating, response inhibition, and generativity

Hot

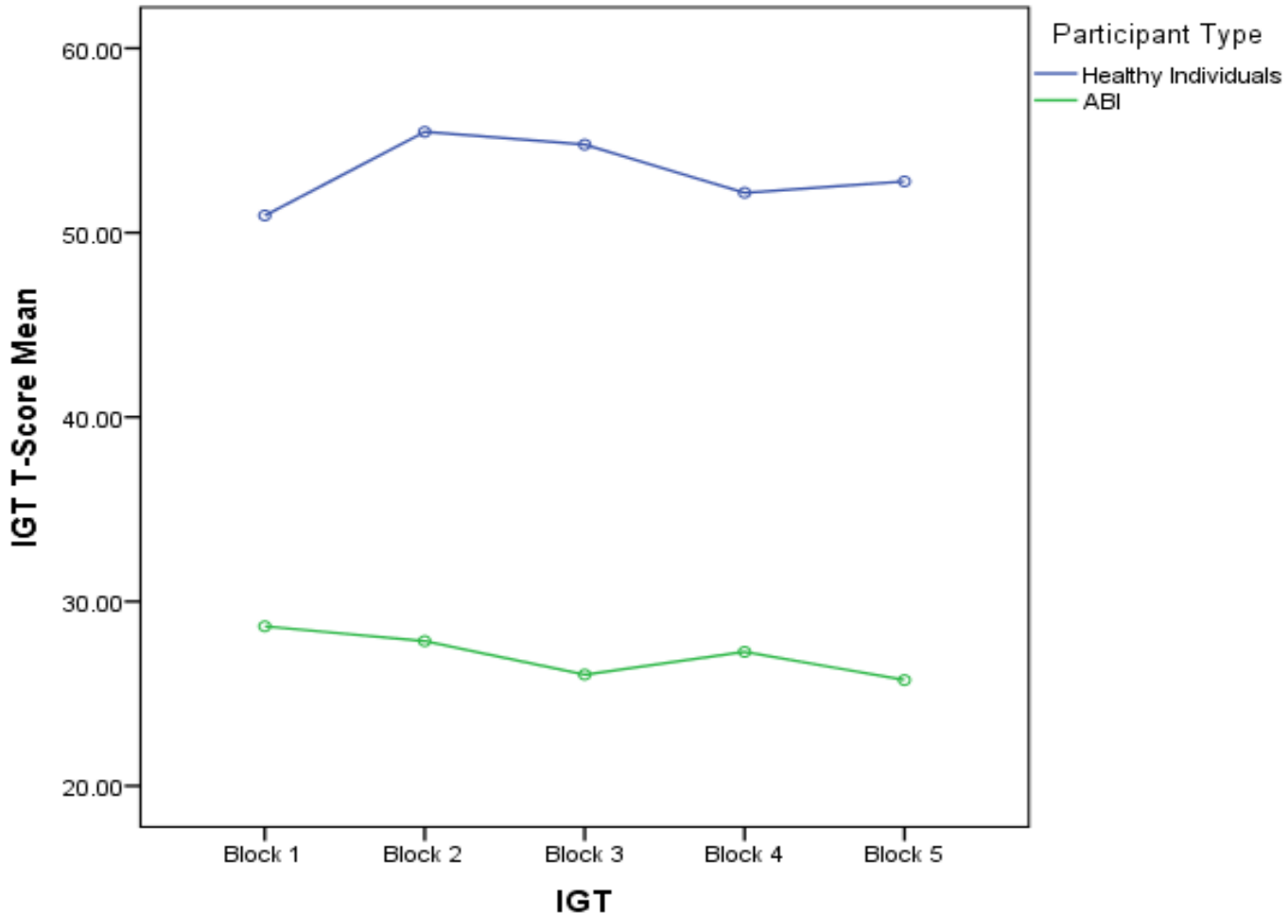
- Used in situations that require emotional or motivational processing
- Includes weighing up risk/reward, delaying gratification, following social norms, or regulating emotional responses

(Brevers et al., 2013; Brock et al., 2009; Chan et al., 2008)

Phineas Gage

(Bechara, 2016; Harlow, 1848; Schneider &Koenigs 2017)

Hot Executive Functioning



Prospective memory

- Remembering to remember
  - E.g., passing on a message to a colleague when you next see them.
  - E.g., taking medication at 8am

Prospective Memory

- Shown to be a major issue in recovery following acquired brain injury
  - Impairments at least as common as retrospective memory impairments (41%)
  - Can interfere with engagement in rehabilitation
  - Important for adhering to sometimes life-saving medical treatments
  - Many family members find it incredibly frustrating

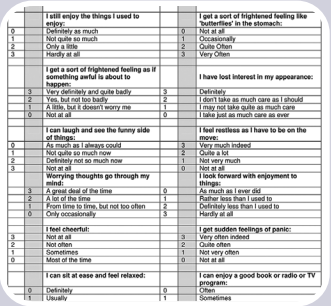
(Kant et al., 2015; Roche et al., 2007; Scullin et al., 2017; Shum et al., 2011; Twamley et al., 2008; Ward et al., 2004)

Emotion and Stroke

24-60% of people experience depression following a stroke

29% of people experience anxiety following a stroke

Mental health problems can be a barrier to rehab



		I still enjoy the things I used to enjoy:			I get a sort of frightened feeling like 'butterflies' in the stomach:
0		Definitely as much		0	Not at all
1		Not quite so much		1	Occasionally
2		Only a little		2	Quite Often
3		Hardly at all		3	Very Often
		I get a sort of frightened feeling as if something awful is about to happen:			I have lost interest in my appearance:
	3	Very definitely and quite badly	3		Definitely
	2	Yes, but not too badly	2		I don't take as much care as I should
	1	A little, but it doesn't worry me	1		I may not take quite as much care
	0	Not at all	0		I take just as much care as ever
		I can laugh and see the funny side of things:			I feel restless as I have to be on the move:
0		As much as I always could		3	Very much indeed
1		Not quite so much now		2	Quite a lot
2		Definitely not so much now		1	Not very much
3		Not at all		0	Not at all
		Worrying thoughts go through my mind:			I look forward with enjoyment to things:
	3	A great deal of the time	0		As much as I ever did
	2	A lot of the time	1		Rather less than I used to
	1	From time to time, but not too often	2		Definitely less than I used to
	0	Only occasionally	3		Hardly at all
		I feel cheerful:			I get sudden feelings of panic:
3		Not at all		3	Very often indeed
2		Not often		2	Quite often
1		Sometimes		1	Not very often
0		Most of the time		0	Not at all
		I can sit at ease and feel relaxed:			I can enjoy a good book or radio or TV program:
	0	Definitely	0		Often
	1	Usually	1		Sometimes

Best practice guidelines recommend mood screening

(Andersen et al., 1995; Broomfield et al., 2014; Eskes et al 2015; Hackett & Anderson, 2005; Kotila 1998; McLean et al., 2019; Nys et al., 2005; Pohjasvaara et al., 2001; Pompili et al., 2012; Rickards, 2005; Stroke Foundation)

Emotion and Stroke

- Mood disorders are often undiagnosed and untreated (Hackett et al., 2005)
- It can be hard to distinguish between mood symptoms and stroke-related impairments (Burton & Tyson, 2015; Hart & Morris, 2007)
- 56% of patients receive mood assessments following stroke (National Stroke Audit – Rehabilitation Services Report, 2018)
  - 1 in 3 do not have access to clinical or clinical neuropsychology

Stroke FOUNDATION

InformMe

Post-Stroke Mood Screening

- Many validated measures (Burton & Tyson, 2015):
  - Hospital Anxiety and Depression Scale (HADS), Patient Health Questionnaire (PHQ-9), Geriatric Depression Scale (GDS-15), Stroke Aphasic Depression Questionnaire–Hospital Version (SADQ-H)
  - Can differ based on age and communication needs
- International guidelines emphasise the importance of staff training and referral pathways (NHS, 2011)

Apathy

Apathy is a disturbance of motivation, characterized by reduced goal-directed behaviour and cognition

Apathy is common following a stroke (approximately 36%)

Associated with cognitive impairment

Most commonly associated with frontal and subcortical lesions (Jorge et al. 2010)

Associated with poorer outcome and poorer engagement in rehabilitation

(Brodaty et al., 2013; Caeiro et al., 2013; Ferro et al., 2016; Hama et al., 2011; Jorge et al., 2010 Tang et al., 2014)

Why measure these skills?

Overlooking impairment can lead to:

- Lack of access to services and rehabilitation
- Poorer quality of life
- Missing the opportunity for understanding problems

Neuropsychological assessment can also help predict functional outcome.

Why is it important to study predictors of outcome?

- Target ‘at risk’ patients
- Psycho-education
- Rehabilitation
- Facilitate long-term follow-up of those with risk factors.

Functional Outcome

a persons' ability to live independently and engage in social relationships, leisure activities, study and/or employment

Predicting outcome

- Age
- Stroke severity
- Lesion location
- Medical comorbidities
- Pre-injury functioning
- Pre-injury substance use
- Social support
- Gender

(Corrigan et al., 1995 ;Dawson et al., 2007; Farace &Alves, 2000; Mushkudiani et al., 2007; Pohjasvaara et al., 2002; Tate &Broe, 1999; Mushkudiani et al., 2007; Pohjasvaara et al., 2002)

Neuropsychological Predictors

Following TBI, NP tests predicted 31.3% of variance in global outcome:

- Verbal Memory
- Visuo-spatial Construction
- Set Shifting
- Verbal Fluency

Following non-traumatic ABI, NP tests predicted 20% of variance in ADLS and 13% of variance in quality of life

(Allanson et al., 2017; Hochstenbach et al., 2001; Patel et al., 2002, Watson et al., n.d.; Zak, 2000)

FEEDBACK

Psychoeducation

Refers to informing an individual (and their family, if relevant) about their specific condition, which can include strengths and weaknesses and how this relates to their stroke.

In people with traumatic brain injuries, giving people personalized information regarding their injury and rehabilitation lead to better outcomes (Pegg et al., 2005)

Stroke Foundation Recommendations

"Findings from neuropsychological testing should be discussed with the patient and family. Education and information should also be provided, verbally and in writing, about strategies which may help the person better engage in rehabilitation."

The importance of awareness

- Impaired self-awareness and insight are common following stroke (up to 70%) (Hartman-Maier et al., 2003)
- A lack of insight can lead to disengagement in rehabilitation and unrealistic goal setting (Fleming & Strong, 1995)
- Higher levels of insight are associated with better outcomes following stroke (Ownsworth et al., 2006)

Intervention

Compensatory Strategies	Structured Rehabilitation
Using strategies based on assessment findings to help compensate for the relative weakness. For example, in people with prospective memory problems you might use a range of different strategies such as environmental cues and alarms to prompt the behaviour.	Using formal rehabilitation programs (e.g., groups or multiple individual sessions) to help the individual build more internal strategies. Goal Management Training (GMT; Levine, 2000) is one such program. It encourages individuals to use a series of structured steps to improve executive functioning and prospective memory.

Referring to Neuropsychology

- Typically seen in the post-acute period following stroke (though there are always exceptions!)
- Public and private services are available in Perth

In Summary

Neuropsychological assessment helps to:

- Characterise the impact of the stroke, including:
  - Novel skills such as hot executive functioning
  - Mood and emotion
- Identify targets for rehabilitation/intervention
- Predict functional outcome

Intervention can:

- Help individuals understand changes following their injury
- Improve self-awareness
- Provide targeted compensatory strategies or structured rehabilitation programs

References

Adams, M. R. V., & Ropper, A. H. (1997). Cerebrovascular Disease. In M. R. V. Adams & A. H. Ropper (Eds.), *Principles of Neurology* (pp. 777–873). New York, NY: McGraw-Hill, Health Professions Division.

Allanson, F., Pestell, C., Gignac, G. E., Yeo, Y. X., & Weinborn, M. (2017). Neuropsychological Predictors of Outcome Following Traumatic Brain Injury in Adults: a Meta-Analysis. *Neuropsychology Review*, 1–15. https://doi.org/10.1007/s11065-017-9353-5

Andersen, G., Vestergaard, K., Ingemann-Nielsen, M., & Lauritzen, L. (1995). Risk factors for post-stroke depression. *Acta Psychiatrica Scandinavica*, *92*(3), 193–198. http://doi.org/10.1111/j.1600-0447.1995.tb09567.x

Bechara, A. (2016). Revisiting Phineas Gage: Lessons we learned from damaged brains. In B. Kolb (Ed.), *Brain and behaviour: revisiting the classic studies.* Sage Publications Ltd.

Brevers, D., Bechara, A., Cleeremans, A., & Noël, X. (2013). Iowa Gambling Task (IGT): Twenty years after - gambling disorder and IGT. *Frontiers in Psychology*, *4*(SEP), 1–14. https://doi.org/10.3389/fpsyg.2013.00665

Brock, L. L., Rimm-Kaufman, S. E., Nathanson, L., & Grimm, K. J. (2009). The contributions of “hot” and “cool” executive function to children’s academic achievement, learning-related behaviors, and engagement in kindergarten. *Early Childhood Research Quarterly*, *24*(3), 337–349. https://doi.org/10.1016/j.ecresq.2009.06.001

Brodaty, H., Liu, Z., Withall, A., & Sachdev, P. S. (2013). The longitudinal course of post-stroke apathy over five years. *The Journal of neuropsychiatry and clinical neurosciences*, *25*(4), 283-291.

Broomfield, N. M., Quinn, T. J., Abdul-Rahim, A. H., Walters, M. R., & Evans, J. J. (2014). Depression and anxiety symptoms post-stroke/TIA: prevalence and associations in cross-sectional data from a regional stroke registry. *BMC neurology*, *14*(1), 198.

Burton, L. J., & Tyson, S. (2015). Screening for mood disorders after stroke: a systematic review of psychometric properties and clinical utility. *Psychological medicine*, *45*(1), 29-49.

Chan, E., Khan, S., Oliver, R., Gill, S. K., Werring, D. J., & Cipolotti, L. (2014). Underestimation of cognitive impairments by the Montreal Caeiro, L., Ferro, J. M., & Costa, J. (2013). Apathy secondary to stroke: a systematic review and meta-analysis. *Cerebrovascular diseases*, *35*(1), 23-39.

Cognitive Assessment (MoCA) in an acute stroke unit population. *Journal of the neurological sciences*, *343*(1-2), 176-179.

Chan, R. C. K., Shum, D., Toulopoulou, T., & Chen, E. Y. H. (2008). Assessment of executive functions: Review of instruments and identification of critical issues. *Archives of Clinical Neuropsychology*, *23*(2), 201–216. https://doi.org/http://dx.doi.org/10.1016/j.acn.2007.08.010

Corrigan, J. D. (1995). Substance abuse as a mediating factor in outcome from traumatic brain injury. *Archives of Physical Medicine and Rehabilitation*, *76*(4), 302–309. https://doi.org/http://dx.doi.org/10.1016/S0003-9993(95)80654-7

Curtiss, G., Klemz, S., & Vanderploeg, R. D. (2000). Acute impact of severe traumatic brain injury on family structure and coping responses. *The Journal of Head Trauma Rehabilitation*, *15*(5), 1113–1122.

Eskes, G. A., Lanctôt, K. L., Herrmann, N., Lindsay, P., Bayley, M., Bouvier, L., ... & Gubitz, G. (2015). Canadian stroke best practice recommendations: mood, cognition and fatigue following stroke practice guidelines, update 2015. *International Journal of Stroke*, *10*(7), 1130-1140.

Feigin, V. L., Barker-Collo, S., Krishnamurthi, R., Theadom, A., & Starkey, N. (2010). Epidemiology of ischaemic stroke and traumatic brain injury. *Best Practice & Research Clinical Anaesthesiology*, *24*(4), 485–494. https://doi.org/10.1016/J.BPA.2010.10.006

References

Ferro, J. M., Caeiro, L., & Figueira, M. L. (2016). Neuropsychiatric sequelae of stroke. *Nature Reviews Neurology*, *12*(5), 269.

Fleming, J., & Strong, J. (1995). Self-awareness of deficits following acquired brain injury: Considerations for rehabilitation. *British Journal of Occupational Therapy*, *58*(2), 55-60.

Hackett, M. L., & Anderson, C. S. (2005). Predictors of depression after stroke: A systematic review of observational studies. *Stroke*, *36*(10), 2296–2301. http://doi.org/10.1161/01.STR.0000183622.75135.a4

Hama, S., Yamashita, H., Yamawaki, S., & Kurisu, K. (2011). Post-stroke depression and apathy: Interactions between functional recovery, lesion location, and emotional response. *Psychogeriatrics*, *11*(1), 68-76.

Harlow, J. M. (1848). Passage of an Iron Rod Through the Head. *Boston Medical and Surgical Journal*, *39*, 389–393.

Hart, S., & Morris, R. (2008). Screening for depression after stroke: an exploration of professionals' compliancewith guidelines. *Clinical Rehabilitation*, *22*(1), 60-70.

Hartman-Maeir, A., Soroker, N., Ring, H., & Katz, N. (2002). Awareness of deficits in stroke rehabilitation. *Journal of rehabilitation medicine*, *34*(4), 158-164.

Hochstenbach, J. B., Anderson, P. G., van Limbeek, J., & Mulder, T. T. (2001). Is there a relation between neuropsychologic variables and quality of life after stroke?. *Archives of physical medicine and rehabilitation*, *82*(10), 1360-1366.

Jokinen, H., Melkas, S., Ylikoski, R., Pohjasvaara, T., Kaste, M., Erkinjuntti, T., & Hietanen, M. (2015). Post-stroke cognitive impairment is common even after successful clinical recovery. *European Journal of Neurology*, *22*(9), 1288-1294.

Jorge, R. E., Starkstein, S. E., & Robinson, R. G. (2010). Apathy following stroke. *The Canadian Journal of Psychiatry*, *55*(6), 350-354.

Kant, N., van den Berg, E., van Zandvoort, M. J., Frijns, C. J., Kappelle, L. J., & Postma, A. (2014). Functional correlates of prospective memory in stroke. *Neuropsychologia*, *60*, 77-83.

Kotila, M., Numminen, H., Waltimo, O., & Kaste, M. (1998). Depression after stroke: results of the FINNSTROKE Study. *Stroke*, *29*(2), 368-372.

McLean, P., Torkington, R., & Ratsch, A. (2019). Development, Implementation, and Outcomes of Post-stroke Mood Assessment Pathways: Implications for Social Workers. *Australian Social Work*, 1-21.

Levine, B., Robertson, I. H., Clare, L., Carter, G., Hong, J., Wilson, B. A., ... & Stuss, D. T. (2000). Rehabilitation of executive functioning: An experimental–clinical validation of Goal Management Training. *Journal of the International Neuropsychological Society*.

Mushkudiani, N. A., Engel, D. E., Steyerberg, E. W., Butcher, I., Lu, J. ., Marmarou, A., … Maas, A. I. R. (2007). Prognostic value of demographic characteristics in traumatic brain injury: Results from the IMPACT study. *Journal of Neurotrauma*, *24*(2), 259–269. https://doi.org/10.1089/neu.2006.0028

Nys, G. M. S., van Zandvoort, M. J. E., van der Worp, H. B., de Haan, E. H. F., de Kort, P. L. M., & Kappelle, L. J. (2005). Early depressive symptoms after stroke: neuropsychological correlates and lesion characteristics. *Journal of the Neurological Sciences*, *228*(1), 27–33. http://doi.org/http://dx.doi.org/10.1016/j.jns.2004.09.031

Ownsworth, T., & Clare, L. (2006). The association between awareness deficits and rehabilitation outcome following acquired brain injury. *Clinical psychology review*, *26*(6), 783-795.

References

Patel, M. D., Coshall, C., Rudd, A. G., & Wolfe, C. D. (2002). Cognitive impairment after stroke: clinical determinants and its associations with long-term stroke outcomes. *Journal of the American Geriatrics Society*, *50*(4), 700-706.

Pegg Jr, P. O., Auerbach, S. M., Seel, R. T., Buenaver, L. F., Kiesler, D. J., & Plybon, L. E. (2005). The Impact of Patient-Centered Information on Patients' Treatment Satisfaction and Outcomes in Traumatic Brain Injury Rehabilitation. *Rehabilitation Psychology*, *50*(4), 366.

Petersen, N., Eslinger, P., Reichwein, R., & Marshall, R. S. (2012). Frontal lobe syndromes. In L. R. Caplan & J. van Gijn (Eds.), *Stroke Syndromes* (3rd ed., pp. 205–2011). Cambridge University Press.

Planton, M., Peiffer, S., Albucher, J. F., Barbeau, E. J., Tardy, J., Pastor, J., ... & Demonet, J. F. (2012). Neuropsychological outcome after a first symptomatic ischaemic stroke with 'good recovery'. *European Journal of Neurology*, *19*(2), 212-219.

Pohjasvaara, T., Leskela, M., Vataja, R., Kalska, H., Ylikoski, R., Hietanen, M., … Erkinjuntti, T. (2002). Post-stroke depression, executive dysfunction and functional outcome. *European Journal of Neurology*, *9*(3), 269–275.

Pohjasvaara, T., Vataja, R., Leppavuori, A., Kaste, M., & Erkinjuntti, T. (2002). Cognitive functions and depression as predictors of poor outcome 15 months after stroke. *Cerebrovascular Diseases*, *14*(3–4), 228–233.

Pompili, M., Venturini, P., Campi, S., Seretti, M. E., Montebovi, F., Lamis, D. A., ... & Girardi, P. (2012). Do stroke patients have an increased risk of developing suicidal ideation or dying by suicide? An overview of the current literature. *CNS neuroscience & therapeutics*, *18*(9), 711-721

Rickards, H. (2005). Depression in neurological disorders: Parkinson's disease, multiple sclerosis, and stroke. *Journal of Neurology, Neurosurgery, and Psychiatry*, *76 Suppl 1*(suppl 1), i48-52. http://doi.org/10.1136/jnnp.2004.060426

Roche, N. L., Moody, A., Szabo, K., Fleming, J. M., & Shum, D. H. K. (2007). Prospective memory in adults with traumatic brain injury: An analysis of perceived reasons for remembering and forgetting. *Neuropsychological Rehabilitation*, *17*(3), 314–334. http://doi.org/10.1080/09602010600831004

Sander, A. M., Caroselli, J. S., Jr, W. M. H., Becker, C., Neese, L., & Scheibel, R. (2002). Relationship of family functioning to progress in a post-acute rehabilitation programme following traumatic brain injury. *Brain Injury*, *16*(8), 649–657.

Schneider, B., & Koenigs, M. (2017). Human lesion studies of ventromedial prefrontal cortex. *Neuropsychologia*, *107*(July), 84–93. https://doi.org/10.1016/j.neuropsychologia.2017.09.035

Scott, J. G., & Schoenberg, M. R. (2011). Frontal Lobe/Executive Functioning. In *The Little Black Book of Neuropsychology* (pp. 219–248). Boston, MA: Springer US. https://doi.org/10.1007/978-0-387-76978-3_10

Shum, D., Levin, H., & Chan, R. C. K. (2011). Prospective memory in patients with closed head injury: A review. *Neuropsychologia*, *49*(8), 2156–2165. http://doi.org/http://dx.doi.org/10.1016/j.neuropsychologia.2011.02.006

Sun, J. H., Tan, L., & Yu, J. T. (2014). Post-stroke cognitive impairment: epidemiology, mechanisms and management. *Annals of translational medicine*, *2*(8).

Tang, W. K., Lau, C. G., Mok, V., Ungvari, G. S., & Watson, P., Gignac, G. E., Weinborn, M., Green, S., & Pestell, C. (n.d.). A Meta-Analysis of Neuropsychological Predictors of Outcome Following Stroke and Other Non-Traumatic Acquired Brain Injuries in Adults.

Tekin, S., & Cummings, J. L. (2002). Frontal–subcortical neuronal circuits and clinical neuropsychiatry: An update. *Journal of Psychosomatic Research*, *53*(2), 647–654. https://doi.org/10.1016/S0022-3999(02)00428-2

References

Twamley, E. W., Woods, S. P., Zurhellen, C. H., Vertinski, M., Narvaez, J. M., Mausbach, B. T., … Jeste, D. V. (2008). Neuropsychological substrates and everyday functioning implications of prospective memory impairment in schizophrenia. *Schizophrenia Research*, *106*(1), 42–49. http://doi.org/http://dx.doi.org/10.1016/j.schres.2007.10.030

Ward, H., Shum, D., Dick, B., McKinlay, L., & Baker-Tweney, S. (2004). Interview study of the effects of paediatric traumatic brain injury on memory. *Brain Injury*, *18*(5), 471–495. http://doi.org/10.1080/02699050310001646107

Watson, P., Gignac, G. E., Weinborn, M., Green, S., & Pestell, C. (n.d.). A Meta-Analysis of Neuropsychological Predictors of Outcome Following Stroke and Other Non-Traumatic Acquired Brain Injuries in Adults.

Woods, S. P., Dawson, M. S., Weber, E., Gibson, S., Grant, I., & Atkinson, J. H. (2009). Timing is everything: Antiretroviral nonadherence is associated with impairment in time-based prospective memory. *Journal of the International Neuropsychological Society*, *15*(01), 42–52. http://doi.org/doi:10.1017/S1355617708090012

Woods, S. P., Weber, E., Weisz, B. M., Twamley, E. W., & Grant, I. (2011). Prospective memory deficits are associated with unemployment in persons living with HIV infection. *Rehabilitation Psychology*, *56*(1), 77.

Woods, S. P., Weinborn, M., Velnoweth, A., Rooney, A., & Bucks, R. S. (2012). Memory for Intentions is Uniquely Associated with Instrumental Activities of Daily Living in Healthy Older Adults. *Journal of the International Neuropsychological Society*, *18*(01), 134–138. http://doi.org/doi:10.1017/S1355617711001263

Wong, K. S. (2014). Apathy and health-related quality of life in stroke. *Archives of physical medicine and rehabilitation*, *95*(5), 857-861.

Zak, M. L. (2000). The impact of post-stroke aphasia and accompanying neuropsychological deficits on caregiving spouses and marriage.